THE

Connecticut Agricultural Experiment Station,

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The Bulletins and Reports of this Station are mailed free to every citizen of Connecticut who applies for them seasonably.

CONTENTS.

THE BABCOCK METHOD OF DETERMINING FAT IN MILK AND CREAM FOR THE USE OF CREAMERIES.

The object of this Bulletin is to call the attention of those concerned to the fact that there are now rapid, practicable and accurate methods of finding the per cent. of fat in cream and milk which are suited to the needs of creameries.

By their use it is possible to pay for milk or cream by the only fair method, i. e., by the actual quantity of fat in them, the raw material which the creamery manufactures.

There are several methods of determining fat which are both rapid and accurate. All of them we have tested more or less, but our experience leads us to regard the Babcock Method as the most desirable being as rapid and as accurate as any and surpassing all others in simplicity. It should be said, however, that others who have had as much experience as ourselves prefer the so-called Beimling Method. There is no question that the choice at present lies between these two methods.

Determination of Fat in Milk.

Details of Making the Determination.—The principle of the Babcock Method is this : to a carefully measured quantity of the milk in a flask provided with a narrow accurately graduated neck, made for the purpose, is added a definite quantity of strong oil of vitriol which dissolves all the solid matters of the milk except the fat. The flasks thus charged, are rapidly whirled in a centrifugal apparatus by which all the fat is brought to the surface of the mixture in a few minutes. Hot water is then added to raise this layer of melted fat into the graduated neck of the flask. The length of the fat layer, as read off on the graduation, gives at once the per cent. of fat. Full particulars regarding the manipulation are provided with the machine.

A considerable number of creamery men and dairy men have availed themselves of the invitation given in our last Bulletin to visit the Station and see the method in operation and we believe it will pay for any in the State who think of getting this Tester to see it here and learn some particulars of manipulation that can be better appreciated by seeing than by reading of them.

The apparatus is sold by Messrs. Cornish, Curtis & Greene, Ft. Atkinson, Wis.

Rapidity of the Test.—This depends largely on the skill and activity of the operator. In the Station laboratory at the time of this writing, a person skilled in handling such apparatus, but who has worked with this method only a few times has made determinations of fat in 40 samples of milk in an hour and forty-eight minutes.

This included time spent in mixing the milk in the sample bottles, measuring both milk, acid and fat, labelling and cleaning all the flasks and apparatus used, recording the results, and leaving every thing in perfect order for the next use; in short *every* thing involved in any way with the operation. This is more than twice as rapid work as we were able to do at first and is made possible simply by having the apparatus conveniently arranged for the work.

Cost of the Test.

The price list of Messrs. Cornish, Curtis & Greene is as follows:

SIZES AND PRICES.

4-bottle Tester	$10.00
6-bottle Tester	12.00
8-bottle Tester	14.00
10-bottle Tester	16.00
15-bottle Tester	18.00
20-bottle Tester	21.00
30-bottle Tester	24.00
25-bottle Power Machine	38.00
35-bottle Power Machine	43.00
50-bottle Power Machine	50.00

Each machine has its full complement of bottles with pipettes, acid measure and acid sufficient for 50 to 100 tests, when shipped, for which no charge is made. We sell at list price.

Boxing, 50 cents.

EXTRAS.

Pipettes	each,	$0.50
Acid Measure	"	.50
Test Bottles	dozen,	5.00
Acid for 110 Tests, in glass		.60

For machines or further information write the sole manufacturers.

If desired this Station will test for purchasers within the State the accuracy of the graduation on the test bottles furnished with the machine.

Accuracy of the method.—The accuracy of this method of determining the quantity of butter-fat in whole milk has been fully tested at several stations and is settled beyond dispute.

Our own tests have given the following results. The average difference between the quantity of fat shown by this method and that shown by the standard method used in chemical laboratories, was less than one one-hundredth of one per cent. in 32 comparative tests. The greatest difference in any single case was .18 per cent. In six cases the difference exceeded .10 per cent. and in 18 cases it was .05 or less.

In 17 cases the standard method gave a lower result than the Babcock method, in 15 cases a higher result.

That is, on the average, where 100 pounds of butter-fat were actually present, the Babcock test showed $99\frac{99}{100}$ pounds.

The widest discrepancy in any single case was $\frac{18}{100}$ pound or about three ounces of fat in 100 pounds.

In the majority of cases the discrepancy was $\frac{4}{5}$ of an ounce or less in 100 pounds of fat.

Accuracy of sampling indispensible.—To get a perfectly fair sample of each patron's milk is the most critical thing of all. As soon and as often as milk stands at rest, its constituents begin to separate, the cream rising to the surface. The contents of a forty quart can may be thoroughly mixed with a long handled dipper *if time and pains are taken to do it*, but it will require more time than one who has not tried it, would suppose to thoroughly mix the whole so that different samples from the same can will show the same quantity of fat when tested.

For sampling large quantities of milk, the Vermont Station, Bulletin No. 21, recommends a sampling tube. This is simply a piece of brass tube of suitable length and an inch in diameter, having an iron wire running through it, centered by a wire loop within the tube near each end. One end of this wire is bent to form a handle, the other bears a disc of sheet iron with a rubber packing over it. The tube is passed vertically downwards in the milk, the disc being kept away from the tube allowing it to fill as it goes down. Then the wire is drawn up, thus closing the bottom of the tube, and the tube is withdrawn, bringing with it a core or section of milk, which should represent accurately the whole quantity of milk.

Frequency of sampling and of analysis.—In the bulletin already quoted, Prof. Cooke recommends analyzing the samples

once a week, but sampling the milk of each patron, three or more days in each week. One way in which this may be done, he describes as follows:—

METHOD OF SAMPLING RECOMMENDED.

Have a pint glass fruit can of the lightning jar pattern for each patron of the creamery; these jars to be permanently numbered with metal labels wired to the jar, and each patron to have a number corresponding to the one on the jar. In the bottom of each of these jars, put one-twentieth of an ounce of powdered corrosive sublimate, to which has been added one one-hundredth of its weight of acid magenta, or any other of the anilin colors, that would not be destroyed under the conditions present. In this way any milk which has the poisonous corrosive sublimate in it will have such a vivid pink color that there will be no danger of any one drinking it by mistake or of its being fed to animals. Any day in the week a correct sample of the milk measuring one-fourth of a pint taken either by a sampling tube or a dipper is put into this jar. Any other day in the week a second sample of the same size and taken in the same way should be added. A third sample taken on any other day may also be added, if great accuracy is desired. The patron should not know beforehand what day these samples are to be taken, and they need not be taken the same day for all the patrons. The cans can be prepared Saturday morning and samples taken any day during the week, so that the patron can never be sure when he brings his milk whether or not a sample is to be taken from that day's milk. At the end of the week the mixed sample is analyzed and its analysis considered to represent the average character of the milk delivered during the week. Three samples would *certainly* be enough to represent the average character of the milk for any one week, and two samples a week, taken each week for a month, would *certainly* be enough to correctly represent the average character of the milk for the month. This amount of corrosive sublimate will keep the milk for ten days in the hottest weather, and does not interfere with the accuracy of the analysis, when the method of analysis described in this bulletin is used. But corrosive sublimate cannot be used for preserving the sample when any of the methods of extracting the fat by ether is used.

When corrosive sublimate is added to samples, and those samples are held for several days in a warm room, it is necessary to be quite careful in the handling of the milk to prevent it churning. The samples cannot be carried from one place to another by team or on the railroad without danger of their churning, and even the mixing should be done with care and done entirely by pouring instead of by shaking.

Prof. Cooke also shows that it is not necessary that the separate samples should be proportional in size to the quantity of milk each day furnished. The error caused by taking samples of uniform size each day is inappreciable.

The Use of the Method in Creameries.—This method can be applied to the testing of cream equally well, as we shall notice later, but applied to milk it is chiefly valuable to those creameries of which there are a number in this State, and a very large number in neighboring States, that collect or receive milk instead of cream, and either set it or remove the fat by the separator. At present payment is made by the hundred weight of milk supplied, with little or no regard to quality.

The great objection to such methods is that they encourage patrons to aim at quantity rather than quality of milk, to keep cows that are large milkers instead of rich milkers, to feed for quantity rather than quality of milk, and in some cases that have been brought to our notice, to reduce milk which was considered too good for the price paid for it with water.

Still others who would scorn to add water, see no harm in taking a little cream for family use from the top of a can after it has stood over night.

One great advantage of the cream gathering system is that it reduces, though it does not by any means eradicate the temptation or the opportunity to "beat" the creamery and the honest milk producer.

The Babcock method offers to creameries a practicable and accurate method of finding out how much butter-fat each patron daily supplies to it.

This being done it is possible to pay not for pounds of milk but for *actual butter-fat.*

This is obviously the only satisfactory method of payment, and wherever introduced it renders watering or skimming unprofitable and gives to those who furnish the richest milk a fair price for it.

To illustrate:—

Since the 24th of October last this Station has determined the fat in 206 samples of milk carefully taken at creameries from the cans of mixed milk brought by individual patrons. Each sample therefore represented the mixed milk of a herd. Most of them were from a single milking, a few were perhaps mixtures of morning and night's milk.

The *average* per cent. of fat in these was 3.98 or in round numbers four per cent. That is if this whole quantity of milk had been mixed thoroughly together, a hundred weight of it would have contained four pounds of butter-fat.

But as was to be expected the milk from the individual dairies was of various quality. The milk of one herd contained 5.25 per cent. of fat, that of another 3.28 per cent. of fat, and while the percentage varied somewhat from day to day yet the milk of certain herds was *uniformly* rich in fat while that of other herds was as *uniformly* poor.

These figures mean that a hundred pounds of milk, furnished by one patron brought to the creamery five and a quarter pounds of fat, but a hundred pounds of milk from his neighbor's herd brought only three and a quarter pounds. This is an extreme case. If for illustration we assume that the milk of A's herd contains 5 per cent. of fat and that of B's herd 3.5 per cent. we have a difference between the herds which is not by any means extreme in Connecticut to-day.

A and B we will suppose produce the same quantity of milk per week, 1500 pounds, and are paid at the rate of $1.10 per hundred or about $2\frac{35}{100}$ cents per quart. (The actual price paid by different creameries is not known). Their receipts are therefore the same, $16.50 per week.

For this, A furnishes to the creamery 75 pounds ($1500 \times \frac{5}{100}$) of butter-fat and B furnishes $52\frac{1}{2}$ pounds.

That is, crediting nothing to the skimmed milk of which each patron supplied the same quantity; A, the patron who produces the richer milk, who has the better cows or who feeds more rationally gets 22 cents a pound for butter-fat, and B the patron whose milk is the poorest, whose herd is poor or feeding injudicious gets 31.4 cents a pound. This is a premium of 10 cents per pound of fat on thin milk, or poor stock and feeding, or on judicious watering of the milk.

It presents little inducement to better the herd or to feed for quality rather than quantity of milk.

It is obviously very unfair to all the parties concerned and bears hardest on A who has an exceptionally good herd or who feeds exceptionally well.

Now suppose this creamery changes its policy and offers as before $1.10 per hundred for "standard" milk containing four per cent. of fat but allows $2\frac{3}{4}$ cents per hundred additional for every "unit" or tenth of a per cent. of fat more than four in the milk and deducts $2\frac{3}{4}$ cents per hundred for every "unit" or tenth per cent. under four.

The two accounts will stand as follows :

A. Milk contains 5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Add for 10 units per hundred, or 150 units of fat @ 2¾ cents	4.13
	$20.63

B. Milk contains 3.5 per cent. of fat.

15 hundred weight of milk, @ $1.10	$16.50
Deduct for 5 units per hundred, or 75 units of fat @ 2¾ cents	2.07
	$14.43

Under this arrangement A has received $20.63 for his 1500 pounds of milk and has furnished 75 pounds of butter-fat. He has therefore received 27½ cents per pound for the butter-fat.

B has received $14.43 cents for 52½ pounds of butter-fat, and for each pound 27.5 cents, the same that his neighbors receive for a like amount of butter-fat.

Neither A nor B can increase their receipts by watering or skimming milk nor by increasing the flow of milk at the expense of quality.

These particular prices are for nothing more than to illustrate the point. The actual rate to be paid must depend of course on what the creamery can produce butter for and sell it for.

It is believed that the practice of paying for butter-fat rather than for milk—which is rendered practicable by the methods referred to in this Bulletin—will gradually reduce the cost of producing butter, will increase the profits of the honest and intelligent patrons and offer more inducement than there now is for improving herds and feeding liberally and for quality rather than quantity of milk.

It must be borne in mind that the Tester shows the percentage of *pure butter-fat* in the milk, not of "cream" or of butter. "Cream" varies much in composition and may contain as low as 16 per cent. of pure butter-fat or as high as 30 per cent. or even higher. Butter contains from 75 to 87 per cent. of pure butter-fat, see analyses on page 10 of this bulletin. More or less of the butter-fat of the milk however is lost in butter making, chiefly in the skimmed milk and in the butter milk.

Determination of Fat in Cream.

The same method Dr. Babcock has applied to cream with success and our own experiments also have convinced us that the fat in cream raised in deep, submerged cans, can be accurately and easily determined by the Babcock Method, the cream being measured in the same way as milk with some slight changes in manipulation.

They have also given a further illustration of what was well known before, that even where the milk of different herds is set in the same way the actual fat in a "space" or any unit of volume varies very considerably, a space of cream from one herd containing a good deal more or less of actual butter-fat than that from another. In a Bulletin shortly to be issued the determination of fat in cream by the Babcock Method will be fully discussed.

BUTTER ANALYSES.

In a following table are given the analyses of eleven samples of butter from private dairies and six samples of creamery butter. These butters were entered in the exhibit at the Connecticut Dairymen's Association which met in Hartford, Jan. 20–22, 1891. The score of points for each butter is also given. The method of making award was as follows: Number of possible points, 100. Minimum number allowed in awarding premiums 85. Divide the total premium by the total number of points scored above the minimum. The quotient is the amount to be awarded for each point scored above the minimum.

To illustrate: Of the creamery butters,

No. 9	scored	14	points	above	the minimum.
" 7	"	14	"	"	
" 4	"	10	"	"	
" 1	"	4	"	"	
" 5	"	3	"	"	
" 6	"	0	"	"	

Total points scored..... 45. Total premium to be divided $70.00. Each point scoring above the minimum therefore gets $\frac{70}{45} = \$1.555$ and the premiums awarded are as follows:—

No. 9 and No. 7, each $21.78, No. 4, $15.55, No. 1, $6.22 and No. 5, $4.67.

Private Dairy Butter.

Scale of Points.

	Perfect.	No. 5.	No. 11.	No. 4.	No. 6.	No. 7.	No. 2.	No. 1.	No. 8.	No. 9.	No. 3.	No. 10.
Flavor	50	48	45	46	44	40	47	30	21	20	20	15
Grain	25	23	23	23	22	23	22	24	17	15	15	5
Color	15	15	15	12	12	12	6	15	14	13	13	3
Salt	5	5	4	4	5	3	3	4	4	3	1	1
Package	5	5	4	5	5	5	1	5	0	4	3	0
Total	100	96	91	90	86	83	79	78	56	55	52	24

Analyses.

Water	10.86	11.01	12.27	8.59	12.74	11.54	10.09	10.99	10.04	9.37	11.38
Curd	1.32	1.28	.91	1.44	1.42	2.00	1.83	2.53	.94	1.24	1.11
Salt	1.86	5.23	1.18	2.32	2.76	4.11	4.22	3.47	2.44	7.83	6.78
Fat	85.96	82.48	85.64	87.65	83.08	82.35	83.86	82.01	86.58	81.56	80.73
	100.0	100 0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Specific gravity of the butter-fat at 100° C.	.8666	.8644	.8667	.8646	.8646	.8657	.8640	.8642	.8652	.8650	.8662

Creamery Butter.

Scale of Points.

	Perfect.	No. 9.	No. 7.	No. 4.	No. 1.	No. 5.	No. 6.
Flavor	50	49	50	48	46	49	44
Grain	25	25	25	23	22	21	21
Color	15	15	14	15	13	10	9
Salt	5	5	5	4	3	3	3
Package	5	5	5	5	5	5	5
Total	100	99	99	95	89	88	82

Analyses.

Water	11.38	8.89	11.38	7.97	8.35	6.54
Curd	.96	.94	1.18	.90	1.00	1.58
Salt	2.65	2.14	3.17	2.88	2.30	3.96
Fat	85.01	88.03	84.27	88.25	88.35	87.92
	100.00	100.00	100.00	100.00	100.00	100.00
Specific gravity of the butter fat at 100° C.	.8644	.8648	.8647	.8644	.8645	.8646

The judge of the creamery butter was Mr. H. K. House of the Allyn House, Hartford ; of the private dairy butter, Mrs. Thomas Fairclough of Waterbury. Tunxis Creamery, Robertsville, and Greens Farms Creamery, Westport, took first premiums.

The average composition of the creamery and private dairy butters and the range of percentage of each ingredient are as follows:

	Creamery Butter.		Private Dairy Butter.	
	Range of percentage.	Average composition.	Range of percentage.	Average composition.
Water	6.5–11.4	**9.1**	8.6–12.7	**10.8**
Curd	.9– 1.6	**1.1**	.9– 2.5	**1.5**
Salt	2.1– 4.0	**2.9**	1.2– 7.8	**3.8**
Fat	84.3–88.4	**86.9**	80.7–87.7	**83.9**
		100.0		**100.0**

The private dairy butters which received the lowest grading for flavor, grain and salt were ones which had the very abnormally high per cents. of salt (6.78 and 7.83).

It is somewhat surprising that No. 11, with 5.23 per cent. of salt, should have scored as high as it did.

The creamery butter as a rule carried 3 per cent. more of actual butter fat than the private creamery butter.

FERTILIZERS.

Duties of Dealers in Fertilizers.

The Connecticut Fertilizer Law holds the SELLER responsible for affixing a correct *label and statement of composition* to every package or lot of fertilizer sold or offered for sale. Purchasers, for their own security, should insist that such statements are supplied.

Every Person who sells commercial fertilizers in Connecticut is also required by law to report certain facts to the Director of this Station and a penalty is provided for neglect to do this.

The law also holds the Seller responsible for the payment of an analysis-fee on every brand of fertilizer sold by him in case the fee is not paid by the manufacturer on or before the first of May annually.

Copies of the law will be sent on application.

Gratuitous Analyses of Fertilizers.

The Station by its authorized agents draws samples of all brands offered for sale in all parts of the State and when possible sends its agents, on request, to sample large lots of goods bought by Granges or Farmers' Clubs.

The coöperation of farmers' organizations is nevertheless desired in calling attention to new brands of fertilizers, and in securing samples.

To insure justice to manufacturers, dealers and consumers alike, the Station will make gratuitous analyses of Commercial Fertilizers *only* on samples taken by the Agents of the Station, or on such other samples as are *fully* described on the Station Forms for Description and taken in accordance with the Station Instructions for sampling, and furthermore are properly authenticated by the certificate of the person drawing the sample, *and in addition* the witness, either

1. Of a Selectman ;
2. Of an Officer of a farmers' club, grange or local agricultural society ; or
3. Of the Dealer from whose stock the sample is taken.

In case a Dealer takes samples of his own stock, the witness of one of the Officers aforesaid will be required.

It is particularly necessary that the *actual cost prices* be given. In case of special rates the Station, if desired, will hold confidential both the names of the seller and buyer, but to make the results of analysis of any general value, and so to justify making the analyses at all it is essential to know the cost of the material.

The Trade-Values for 1891 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows :

	Cts. per lb.
Nitrogen in ammonia salts	18⅓
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	15½
in cotton seed meal and castor-pomace	15
in fine bone and tankage	15
in fine medium bone and taukage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7

Phosphoric acid, soluble in water	8
in ammonium citrate*	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
as muriate	4½

These Trade-Values are the average prices at which in the six months preceding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. They have been agreed upon by the Experiment Stations of Massachusetts, New Jersey and Connecticut for use in their respective States during 1891. The valuations obtained by use of the above figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as :

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Ammonite,
Dried Blood,	Dry Ground Fish,
Muriate of Potash,	Bone or Tankage,
Sulphate of Potash,	Ground So. Carolina Rock,

Plain Superphosphate.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Valuation of a Fertilizer consists in calculating the *retail Trade-value* or *cash-cost* at trade centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Organic nitrogen in Mixed Fertilizers is reckoned at 15½ cents, the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 2 cents. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of potash is reckoned at 5½ cents.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail cash price charged for these goods at the factory. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. These charges are for grinding and mixing, bagging or barreling, storage, commission to agents and dealers, interest on investment, and finally, profits. If the purchaser buys on credit, the price of the fertilizer is commonly made to cover interest.